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17/ENG03/013.
ASSIGNMENT.

Question No 1

a) To prevent Overturning, sliding or buckling of the structure, or parts of it, under the action of loads.

To resist safely the stresses induced by the loads in the various structural members.

To investigate the strength, stability and rigidity of structures.

To ensure structural safety.

b) The elastic method of design provides thicker sections while limit state method provides thinner sections.

The elastic method design has no factor of ~~f~~ safety used for loads while the limit state method has partial safety factors used for loads.

The elastic method design is less economical while limit state method is more economical.

Exact margin of safety for elastic state method is unknown while exact margin of safety for limit state method is known.

c) $F_D = 410 N/mm^2$

$T_{cx} = 25 N/mm^2$

$P_{ioR} = 150 mm = 0.15m$

$Thread = 275mm = 0.275m.$

Slab thickness = 150mm.

Solution

Slope factor = $SF = \frac{\sqrt{R^2 + T^2}}{T}$

$= \frac{\sqrt{150^2 + 275^2}}{275}$

$= \frac{\sqrt{22500 + 73625}}{150}$

$= \underline{\underline{1.14}}.$

Loading.

Waist, A : $0.15 \times 24 = 0.6 KN/m^2$.

Finishes, B : $1.2 KN/m^2$

Steps, C : $0.275 \times 0.15 \times 24 = 3.3 KN/m^2$

$G_K = ((A + B) \times SF) + C$

$= ((3.6 + 1.2) \times 1.14) + 3.3.$

$= (4.8 \times 1.14 + 3.3)$

$= 8.77 KN/m.$

$D.L, F = 1.4 G_K + 1.6 Q_K.$

$= 1.4(8.77) + 1.6(1.5)$

$= 14.68 KN/m^2.$

Span = Total + 0.5 (la + lb) = (275×12) + 0.5 (225 + 225) = 3.525m

$d = h - cover - \frac{1}{2}\phi$

$= 150 - 25 - 6 = 119mm.$

$M = \frac{FL^2}{10} = \frac{14.68 \times 3.525^2}{10} = 18.24 KNm.$

$K = \frac{M}{bd F_{cu}} = \frac{18.24 \times 10^6}{1000 \times 119^2 \times 25}$

$= 0.052.$

$$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.052}{0.9}}$$

$$= 0.938.$$

$z = I_a d = 0.938 \times 119 = 111.622\,mm.$

$$A_s = \frac{M}{0.95 f_y z} = \frac{18.24 \times 10^6}{0.95 \times 410 \times 111.622} = 419.53.$$

$A_{s,prov} = 482mm$

provide Y12 @ 259 c/c ($A_{s,prov} = 452mm$).

Deflection Check.

$$f_s = 2/3 \times 1/\beta \times \frac{A_{req}}{A_{prov}} \times f_{yk}.$$

$$f_s = 2/3 \times 1 \times 419.53/452 \times 250.$$

$$= 154.69\ N/mm^2$$

$$M.F = 0.56 + \frac{477 - 154.69}{120\left(0.9 + 18.24 \times 10^6/1000 \times 119^2\right)}$$

$$= 1.78.$$

d_{req} = Span / $\alpha_f \times$ edp

$$= \frac{3525}{1.78 \times 26}$$

$$= 76.17mm.$$

since $d_{req} < d$, Deflection is OK.

Question No 2.

2a) $P_1 = P_2 = P_3 = \frac{4300}{4000} = 1.075 < 2.$ [2-way slab since $1.075 < 2$]

$P_4 = P_5 = P_6 = \frac{4300}{4000} = 1.075 < 2$ [2-way slab since $1.075 < 2$].

$P_7 = P_8 = P_9 = \frac{4500}{4000} = 1.125 < 2$ [2-way slab since $1.125 < 2$]

$P_{10} = P_{11} = P_{12} = \frac{4000}{1500} = 2.67 > 2$ [1-way slab since $2.67 > 2$]

Designing f_a

$l_y / l_x = \frac{4300}{4000} = 1.075 \simeq 1.1.$

Assuming.

Slab thickness $= 175mm \simeq 0.175m.$

$F_{cu} = 25 N/mm^2$

$F_S = 410 N/mm^2.$

$D.L = (1.4 \times 6.4) + (1.5 \times 5)$

$= 16.96 KN/m^2 \simeq 17 KN/m^2.$

Short span Coefficient $= 0.044,\ 0.033.$

Long span Coefficient $= 0.037,\ 0.028.$

Short Span.

Mid span.

$M = B_x\ W l_x^2 = 0.033 \times 17 \times 4^2$

$= 8.976\ KNM$

$d = h - cover - \frac{1}{2}\phi = 175 - 25 - (\frac{1}{2} \times 12)$

$= 144.$

$K = \frac{M}{bd^2 F_{cu}} = \frac{8.976 \times 10^6}{1000 \times 144^2 \times 25}$

$= 0.0173.$

$I_a = 0.5 \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0173}{0.9}}$

$= 0.98\ (= 0.98)$

$Z = I_a d = 0.95 \times 144$

$= 136.8mm.$

$A_s = \frac{M}{0.95\ F_{s} Z} = \frac{8.976 \times 10^6}{0.98 \times 410 \times 136.8}$

$= 168.258 mm^2.$

provide Y_{12} @ 300 c/c $(A = 377mm)$.

Continuous edge

$M = \beta_2 wl_x^2 = 0.044 \times 17 \times 4^2 = 11.968$

$K = \frac{M}{bd^2 F_{cu}} = \frac{11.968 \times 10^6}{1000 \times 144^2 \times 25}$

$= 0.023.$

$I_a = 0.5 \sqrt{0.25 - \frac{K}{0.7}} = 0.5 + \sqrt{0.25 - \frac{0.023}{0.9}}$

$= 0.976 (= 0.95)$

$Z = I_a d = 0.97 \times 144$

$= 136.68$

$A_s = \frac{M}{0.95 F_y z} = \frac{11.968 \times 10^6}{0.95 \times 410 \times 136.68}$

$= 224.61 mm^2.$

Provide Y10 @ 300 c/c $(A = 377 mm^2)$.

Long span

Mid-span.

$M = \beta_x wl_x = 0.028 \times 17 \times 4^2.$

$= 7.616.$

$d = 144 - 12$

$= 132 mm.$

$K = \frac{M}{bd^2 F_{cu}} = \frac{7.616 \times 10^6}{1000 \times 132^2 \times 25}$

$= 0.017.$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.017}{0.9}}$

$= 0.98 (\leq 0.95).$

$Z = I_a d = 0.95 \times 132$

$= 125.4.$

$A_s = \frac{M}{0.95 F_y z} = \frac{7.616 \times 10^6}{0.95 \times 410 \times 125.4}$

$= 155.93.$

Provide Y12 @ 300 c/c $(A = 377 mm^2$

Continuous Edge.

$M = \beta_x W l_x^2 = 0.037 \times 17 \times 4^2$

$= 10.064.$

$K = \frac{M}{bd^2 F_{cu}} = \frac{10.064 \times 10^6}{1000 \times 132^2 \times 25}$

$= 0.0231.$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0231}{0.9}}$

$= 0.97 \; (< 0.95).$

$Z = I_a d = 0.95 \times 132$

$= 125.4.$

$A_s = \frac{M}{0.95 F_y Z} = \frac{10.064 \times 10^6}{0.95 \times 410 \times 125.4}$

$= 206.05.$

provide Y12 @ 300 c/c $(A = 377 \, mm^2)$.

Deflection Check.

$d_{req} = \frac{span}{M.F. \times \text{effective depth ratio}}$

$M.F = 0.55 + \frac{477 - F_s}{120\left(0.9 + M/bd^2\right)} \leq 2$

$F_s = \frac{2}{3} \times \frac{1}{\beta} \cdot \frac{A_{req}}{A_{prov}} > F_y$

$\beta = 1$

$= \frac{2}{3} \times 1 \times \frac{224.61}{377} \times 250$

$= 98.33$

$M.F = 0.55 + \frac{477 - 98.33}{120\left(0.9 + \frac{11.968 \times 10^6}{1000 \times 144^2}\right)}$

$= 2.68 > 2.$

$$d_{req} = \frac{4 \times 1000}{2 \times 26}$$

$$= 76.92$$

Deflection is OK.